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1. Your reference

MTW 50638

2. Patent application number
(The Patent Office will fill in this part)

9815730.8

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

IMPERIAL CHEMICAL INDUSTRIES PLC
IMPERIAL CHEMICAL HOUSE
MILLBANK, LONDON, SW1P 3JF.

Patents ADP number *(if you know it)*

935003

If the applicant is a corporate body, give the country/state of its incorporation

UNITED KINGDOM

4. Title of the invention

POLYMER COMPOSITION

5. Name of your agent *(if you have one)*

GIBSON, SARA HILLARY MARGARET

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

ICI GROUP INTELLECTUAL PROPERTY
PO BOX 90, WILTON, MIDDLESBROUGH
CLEVELAND, ENGLAND, TS90 8JE.

Patents ADP number *(if you know it)*

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

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a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

c) any named applicant is a corporate body.

See note (d))

YES

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	–
Description	5
Claim(s)	–
Abstract	–
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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
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11. I/We request the grant of a patent on the basis of this application.
IMPERIAL CHEMICAL INDUSTRIES PLC

Signature S M Gibson Date 20 JULY 1998

12. Name and daytime telephone number of person to contact in the United Kingdom DR SARA HILLARY MARGARET GIBSON (01642 436282)

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Polymer Composition

The present invention relates to an abrasion resistant polymer composition and a process for its preparation.

Acrylic polymer compositions where the base polymer comprises, for example, a poly(alkyl (meth)acrylate) as a homopolymer or a copolymer, and processes for their manufacture, are well known. The performance of these polymers for various application areas can be enhanced by for example the addition of additives such as lubricants for mould release, thermal stabilisers, UV absorbers for long term external weathering, colours, impact modifiers etc..

One major application area for acrylic compositions is vacuum (thermo)forming into for example baths, sinks, vanity units and shower trays. It is important that these final articles have as large a resistance to abrasion as possible. A method that is currently used to improve abrasion resistance is the application of an abrasion resistant coating to a cast acrylic sheet. The coating is typically applied in solution to the cast acrylic sheet prior to being cured, for example by radiation (UV), solvent evaporation, thermal initiation. EP 571808 B1 discloses antifogging film, plates and articles comprising an acrylic polymer support and a polymerised and UV reticulated abrasion resistant coating containing acrylic monomers and hydrophilic metal oxide(s). Examples of components within the coating that are thought to provide the abrasion resistant property are titanium, silica, aluminium compounds. Unfortunately this method of creating an abrasion resistant cast acrylic sheet can limit the application areas of the cast acrylic sheet. For example an abrasion resistant cast sheet thus prepared can not be readily vacuum (thermo)formed.

The addition of fillers such as silica or alumina particles at high levels to acrylic polymerisable compositions to produce a liquid dispersion followed by curing to form an opaque composite material is known . The addition of these fillers at low levels may give some abrasion resistance properties but the polymer formed is hazy and hence has poor optical properties.

Accordingly, in a first aspect, the present invention provides a polymerisable composition comprising a major amount of at least one polymerisable acrylic compound, 0.2 - 2% by weight of the composition of a finely divided compound comprising at least one oxide selected from silicon, titanium, zirconium and

aluminium oxides, said composition including 1-4 times the weight of the oxide of at least one organic compound miscible with said polymerisable acrylic compound.

In a second aspect the present invention provides a product of polymerising a polymerisable composition comprising

(a) At least 90% at least one polymerisable acrylic compound.

(b) 0.2 to 2% by weight of the composition of finely divided compound comprising at least one oxide selected from silicon, titanium, zirconium and aluminium oxides.

(c) 1-4 times the weight of the oxide of at least one organic compound miscible with said polymerisable acrylic compound.

In a third aspect the present invention provides a process for forming a product of polymerising a polymerisable composition

which process comprises the steps of

(i) Mixing a dispersion of 0.2 to 2% by weight finely divided compound comprising at least one oxide selected from silicon, titanium, zirconium and aluminium oxides in 1-4 times the weight of the oxide of at least one organic compound with at least 90% of the at least one polymerisable acrylic compound and a free radical initiator

(ii) Polymerising the mixture in a cast cell

Surprisingly it has been found that the addition of a minor amount of a typical coating solution containing an abrasion resistant component to the monomer composition used to make the acrylic polymer, followed by polymerisation results in a polymer with good optical properties and also improved abrasion resistant properties compared to the base polymer.

The acrylic polymers that can be produced according to this invention include homo and copolymers of the corresponding polymerisable acrylic compounds such as alkyl (alk)acrylic acid and esters thereof, functionalised alkyl(alk)acrylic acid and esters thereof, for example hydroxy, halogen, amine functionalised. For both (alk)acrylic acid and esters thereof, more preferably alkyl(meth)acrylates. For copolymers the preference is of a major amount of an alkyl methacrylate and a minor amount of an alkyl acrylate as the polymerisable acrylic compounds . More preferably

the alkyl acrylate is present at up to 12% w/w in the at least one polymerisable acrylic compound.

The at least one organic compound preferably contains at least one functional group such as an acrylate group, for example hydroxyethylmethacrylate (HEMA), hexanedioldiacrylate, tripropylglycolmethacrylate or a hydroxyl group.

The finely divided oxide compound preferably has an average particle size between 10 and 50nm, more preferably between 10 and 35nm. It is present at 0.2 to 2% by weight in the polymerisable composition, more preferably at 0.5 to 1.5% by weight. Preferably the oxide compound is colloidal silica.

Preferably a dispersion is formed of the oxide in the said at least one organic compound . This dispersion can be then added to the least one polymerisable acrylic compound. This dispersion is preferably present at 0.2 to 4%, more preferably 2 to 3% by weight in the polymerisable composition.

Polymerisation can be undertaken using conventional free radical or anionic or other polymerisation techniques, for example bulk, solution or suspension with the addition of suitable initiators and optionally chain transfer agents. The acrylic polymer produced, in accordance with the present invention, may be in the form of sheets which can be readily thermo(formed) or powders which may be extruded.

The present invention is illustrated by reference to the following examples.

EXAMPLE 1

Preparation of abrasion resistant cast polymethylmethacrylate sheet (PMMA)

2,2 - azobisisobutyronitrile (0.08% by weight), colloidal silica of a particle size 13-30nm as a 30% by weight dispersion in HEMA (2.5% by weight), with the balance of the composition being made up of methylmethacrylate (MMA) syrup were mixed together using a Silverson Model L4R high shearing machine for 1 minute at maximum setting. The mixture was placed in a cast cell, between two glass sheets spaced 3.2 mm apart from each other by a non metallic gasket. The cast cell was sealed and immersed in a water bath at 45 °C for 20 hours. The mixture was then post cured for 2 hours at 60 °C followed by 2 hours at 80 °C followed by heating at a rate of 0.5 °C /min up to 118 °C. The cell was held at 118 °C for 1 hour. The cell was then cooled and the glass sheets removed to give a cast PMMA sheet.

The cast PMMA sheet at a thickness of 3mm, was (thermo)formed by

placing a mould and sheet assembly in an electric oven preheated at 180 °C for 30 minutes. A two stage rotary vacuum pump was attached to the mould and maximum vacuum applied (indicated 30 inches Hg). Once thermoforming had been completed the assembly was cooled, still under vacuum, until the PMMA surface temperature had dropped to 80 °C or below. The moulded article was then removed from the mould.

5cm^2 samples of the cast PMMA were abraded by rotating a 33mm diameter circular abrasive disc (aluminium oxide bonded in resin fibres) for 60 seconds at a constant 180 rpm under loading forces of 1, 10 and 20 Newtons (N) respectively. The amount of abrasion resistance of each sample was then measured on a spectrophotometer by determining the light transmission and haze, in accordance with ASTM D1925-76. The results are shown in Table One

Table One

Loading Force (N)	0	1	10	20
Haze	1.6	9.7	13.5	16.6
Light Transmission	90.4	88.8	87.3	85.9

EXAMPLE 2 - Comparative

5cm^2 samples of standard cast PMMA, i.e. MMA polymerised without the presence of the oxide compound, were abraded and the optical properties measured as described in Example 1. The results are shown in Table Two

Table Two

Loading Force (N)	0	1	10	20
Haze	0.2	19.9	34.9	31.6
Light Transmission	92.4	86.7	80.9	82.5

The results in Tables One and Two clearly show that when abraded the PMMA of the present invention is less hazy than the standard PMMA.

5cm^2 samples of standard cast PMMA coated at 4 microns thickness with a UV cured commercially available coating known as "UVECRYL 29203" (an aliphatic urethane acrylate) were abraded on the coated surface. The optical properties were measured

as described in Example 1. The results are shown in Table Three

Table Three

Loading Force (N)	0	1	10	20
Haze	0.1	8.5	10.0	27.0
Light Transmission	92.1	88.9	85.9	84.5

The results in Tables One and Three clearly show that when abraded, the PMMA of the present invention is comparable in abrasion resistance performance to PMMA coated with "UVECRYL 29203".

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